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Doctoral Degree

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Synopsis for Registration as Research Scholar

for

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on

Performance improvement of Wireless Networks using soft-computing algorithms

By

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Abstract of proposed work plan

With growing wireless networks, there is demand for efficient and optimal wireless networks. The performance of these wireless networks can be improved using optimization techniques. The optimality criteria of wireless networks depend on its architecture and purpose of the network. Gradient based traditional optimization are specific to given network. For large wireless networks, it become difficult to provide exact optimal solutions using traditional optimization techniques. In case of large network problems, traditional methods may lead to local optimal solutions. Recently, researchers have started exploring use of soft computing algorithms for performance improvement of wireless networks. Soft computing algorithms have various advantages over the traditional algorithms viz. easy to apply, can be applied to complex problems and provide global optimal solutions [1]. Advanced soft computing algorithms have shown great results in various other areas of research [2]. This study is focused on utilizing the potentials of soft-computing algorithms to improve various aspects of wireless networks.

1. Introduction

Utilization of traditional algorithms for performance improvement of Wireless Networks becomes difficult as the systems are not available in specific format or in the analytical expression format. Therefore, the obtaining the gradients of the performances of these systems also becomes difficult. The outcomes of the wireless networks are also dependent on various aspects of the network architecture which makes it difficult to utilize the traditional performance enhancement algorithms. The advantages of soft-computing algorithms include easy implementation even in case varying network architecture, global solution of improved performance and performance improvement under probabilistic conditions.

The performance improvement parameters and strategies are dependent on the type of wireless network architecture considered for the analysis. The typical wireless architectures are Wireless Personal Area Network(WPANs), Wireless Local Area Networks(WLANs), Wireless Metropolitan Area Networks (WMANs) and Wireless Wide Area Network (WWANs). The issues related to these networks are shared media, Increased bit error rate (BER), Lower radio transmission power, Scattering, Reflection, Diffraction, Multipath propagation, Fading and RF signal interference.

2. Literature Survey

Literature survey briefs about the previous optimization efforts and utilization of soft computing algorithms for optimization as well as control strategies of wireless networks. The most recent and key references are summarized below:

Tychogiorgos et al. [3] presented a new optimization framework that can provide the theoretical foundations of such a protocol by proving a sufficient, and in some cases also necessary, condition for distributed solution of non-convex problems. The wide applicability of this general framework was illustrated by considering a resource allocation

formulation in TDMA/CDMA ad-hoc networks. They presented the performance of the proposed methodology through evaluation and its comparison against other approaches in literature by simulation.

Niyato et al. [4] presented the analysis and optimization of an individual node in the network, for the network operating on a TDMA protocol with wireless energy transfer. The objective of the study was to maximize the network utility defined in terms of throughput and the number of packets in the queue such that the packet loss probability was maintained below the threshold.

Alvandi et. al. [5] performed minimization of packet delay in a TDMA-based MWN by jointly utilizing NC and SIC techniques for a given traffic demand matrix with the assumption of conflict free scheduling and allowing multipath routing. They formulated a cross-layer optimization that assigns time slots to links in a way that the average packet delay was minimized. They developed a heuristic approach for large network optimization which show that the average packet delay and traffic handling capacity of a network, using w/o NC+SIC, NC, SIC and NC+SIC schemes, improves from left to right.

Suzhi and Zhang [6] performed the placement optimization of energy and information access points in WPCNs, where the wireless devices (WDs) harvest the radio frequency energy transferred by dedicated energy nodes (ENs) in the downlink, and use the harvested energy to transmit data to information access points (APs) in the uplink. The simulation results confirmed that the proposed methods can effectively reduce the network deployment cost and yet guarantee the given performance requirements, which is a key consideration in future applications of WPCNs.

Benyamina et al. [7] a new approach to optimize the planning of WMNs that guarantees an acceptable level of network performance prior to its deployment. They implemented a simultaneous optimization process of network deployment cost and network throughput objectives while taking into account all the parameters that have a significant impact on the network efficiency. Using the network simulator OMNET++, they evaluated the three models viz. Load-Balanced Model, Flow-Capacity Model and Interference Model in terms of the actual performance (network throughput). The results of the study showed that Load-Balanced Model totally supersedes the Flow-Capacity Model and performs better than the Interference Model

Khoukhi et al. [8] proposed a novel model, called FuzzyWMN, which can be used to implement traffic adaptation in Wireless Mesh Networks (WMNs). Through extensive simulations demonstrates that FuzzyWMN achieved stable end-to-end delay and good throughput under different network conditions.

Kustiawan and Chi [9] proposed a Kalman filtering and fuzzy logicapproach for reducing handoff initiations, so as to support seamless communication. Kalman filtering was used as a channel equalization technique in channel propagation model, while a Mamdani fuzzy logic was applied subsequently for handoff decision. Simulation results showed that the proposed method reduces handoff initiations effectively.

Nayak and Devulapalli [10] presented a fuzzy logic based algorithm for WSN to extend

network lifetime. They used fuzzy inference engine (Mamdani's rule) to elect the chance to be the SCH. Their results derived from NS-2 simulator and showed that the proposed protocol performs better than the LEACH protocol in terms of the first node dies, half node alive, better stability, and better lifetime.

Summary: Literature survey indicates the wireless network performance improvement strategies are evolved over a period by considering various aspects of network optimization. However, most of the efforts are carried out by making few modifications in traditional optimization algorithms. Some of the soft-computing efforts are focused on utilizing the fuzzy logic for developing expert systems for congestion avoiding of the networks. Therefore, there is considerable scope in utilizing the advanced soft computing methods for optimization and control strategies. Combined and simultaneous use of soft-computing algorithms can also be explored. Furthermore, hybrid soft computing algorithms have shown the great potential in other areas of research which can be explored for wireless networks.

3. Objectives of Research Work

Following are the objectives of research work:

1. To develop simulation models for wireless network with different architectures
2. To perform the parametric studies of developed wireless networks for various purposes.
3. To identify suitable soft-computing algorithms required for network performance improvement
4. To demonstrate use of soft-computing methods for wireless network performance improvement

Brief Methodology followed to achieve above objectives is summarized below:

- The suitable simulations software viz. NS2, NS3, OMNet++, GloMoSim, and MATLAB based models etc. to design to suitable wireless networks. It's performance validation and basic checks will be performed.
- Network performance improvement problems are usually solved with cost constraint. The performance improvement can be achieved by strategically placing the extra network devices. However, this adds up the cost of networking. Therefore, an appropriate trade-off strategy has to decided to achieve the golden mean. Sometimes, this can be achieved by solving multi-objective problem of minimizing deployment cost and maximization of throughput. Even though, minimization of the deployment cost objective is straightforward, maximization of throughput needs balancing of the loads over network channels, minimizing the aggregation of network interferences, or maximizing the culmination of the flows over the entire network. Various soft-computing optimization strategies will be utilized for network performance improvement.
- These optimization requirements are again dependent on the requirement of level of data transmitted. For example, for real time applications like VoIP, VC, and playing game etc. requires minimum level of delay and throughput to avoid delay and data loss whereas for wireless Body area networks(WBAN) needs management of device specific data rate and priority. Therefore, Fuzzy logic approach can be utilized for developing expert system to

regulate source node pocket sizes based on the network conditions to make sure to reach target throughput and pass beneath the maximum allowed delay for real time application to avoid unnecessary offloading. Another use of expert systems is to guarantee high level of reliability of multi-level reliability through efficient usage of bandwidth by improving throughput and reducing collision. Various soft computing based expert systems needs to be developed by network performance improvement.

- After performing preliminary trials of the soft computing algorithms for network optimization and expert system development, these algorithms will be demonstrated for detailed near real-life wireless network problems.

4. Importance of study

Wireless networks are among the fastest growing areas in networking research. Wireless communication has achieved almost similar capabilities of fixed networks that include location-independent information storage, transport, retrieval and processing and to support mobility of terminals and users. Future, wireless networks allow people on the move to communicate with anyone, anywhere and at any time using a rage of multi-media services and heterogeneous platforms, networks, and devices. Wireless networks play a major role in the application of active networking technology. These technologies are expected to provide a wide variety of real-time applications; hence, there is a vital need to provide quality-of-Service (QoS) support.

5. Proposed work Plan

Sr. No.	Year	Details of work carried out
1	2016-17	Literature Survey. Problem Formulation and Synopsis Write up. Course work completion and developing simulation models of various wireless network architecture (Objective-1)
2	2017-18	To perform the parametric studies of developed wireless network architecture (Objective-2) and To identify suitable soft-computing algorithms required for network performance improvement (Objective-3)
3	2018-19	To demonstrate use of soft-computing methods for wireless network performance improvement (Objective-4) Summarization, comparative analysis and publications

6. References

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